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Ratooning Ability of two Sugar Cane varieties affected by Whip Smut (*Sporisorium scitamineum.* Sydow) at Badeggi, NIGERIA

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ABSTRACT

Two varieties of sugar cane, Bida local and Co 957 were inoculated with four levels of *Sporisorium scitamineum* inoculum, 0 x 10^6, 2 x 10^6, 4 x 10^6 and 6 x 10^6 teliospores/ml respectively and planted in a split plot design in four replicates at Badeggi (lat.9°045'N; long 6°07'E at an altitude of 70.57m above sea level), between 1998 and 2000. Results showed that their ratooning ability was significantly impaired by the effect of whip smut. Bida local chewing sugar cane significantly had the least number of tillers and the highest number of dead stools than Co 957 in both plant and ratoon crop cycles of 1998, 1999 and 2000. The 6 x 10^6 teliospores/ml inoculum concentration recorded the least number of tillers and the highest number of dead stools as well as the lowest yield in the two test cane varieties. The ability of a cane variety to produce large number of tillers is an indication of its high tonnage yield. The significantly reduced number of tillers in Bida local with the consequent dead stools resulted in its poor ratoonability and lower yield than Co 957. The implication is that chewing sugar cane should be effectively managed against infection by *S. scitamineum* as its effect, particularly on the ratoon crop destroys and kills the cane, producing dead stools resulting in total loss to the grower. Chewing cane growers at present avoid maintaining the ratoon of their canes to escape this loss but incur additional wages and cost on land preparation and seed cane.

Key words: Infection, *Sporisorium scitamineum,* dead stools, ratoon crop, chewing sugar cane.

INTRODUCTION

Sugar cane (*Saccharum* hybrids) is extensively cultivated by resource poor farmers and sugar estates located in the Northern and southern Guinea Savannah ecological zones of Nigeria. The type of cane grown by resource poor-farmers on 0.2 – 0.8ha scattered all over the country, is the soft rinded and robust cane, known as chewing cane. The type grown by the sugar estates is hard rinded and thin. Both types of cane are attacked by diseases in Nigeria and elsewhere (1).

Steady production of sugar cane by both sugar estates and smallholder farmers in Nigeria, has been hampered by a number of cane diseases of great importance (2, 3, 4, and 5). The following sugar cane diseases have been reported to occur in Nigeria: whip smut (*Sporisorium scitamineum* H. Sydow.), red rot (*Glomerella tucumanensis* (Speg) v. Arx & Muller); leaf blast (*Paraphaeospharia michotii* (Westend) O. Erikss); leaf scald (*Xanthomonas albilineans* (Ashby) Dowson); leaf scorch (*Stagnospora sacchari* Lo & Ling); pineapple disease (*Ceratocystis paradoxa* (Dade) C. Moreau); Pokkal boeng chlorosis (*Gibberella*

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fujikuroi (Saw) Ito apud & Kirmura) (2).

Others include banded sclerotia disease; brown stripe (*Drechsleara sterospila* (Drechsler) Subram & Jain); ratoon stunting disease (RSD) (*Leifsonia xlyli* subsp *xlyli* Davis, Gillaspie, Vidaver & Harris); red stripe (*Pseudomonas rubrilineans* Lee, Purdy, Barnum & Martin), Stapp. The rest are mottled stripe (*Pseudomonas rubrisulbabicans* Christopher & Edgerton) Krasil'rikov); wilt of sugar cane (*G. fujikuroi* var. *subglutinans* Edwards); Curvularia leaf spot (*Cochliobolus lunatus*, Nelson & Haasis); sugar cane mosaic (SCMV) and five others (2). The most important of these diseases has also been reported (3, 4 and 5). Smut, red rot and leaf blast stand out as the most common but smut is obviously the most important (3).

Four smut diseases of sugar cane are recognized: floral smut (*Sphacelotheca cruenta* (Kuehn) Potter), covered smut (*Sphacelotheca macrospora* Yen and Wang), false floral smut (*Claviceps* sp plus *Epicoceum* sp) and culmicolus or whip smut (*Sporisorium. scitamineum* Sydow) [M. Piepenbr., M. Stoll & Oberw. 2002 (Syn: *Ustilago scitaminea* H. & P.Sydow)]. Of these, whip smut is the most widespread and has been of importance at one time or another in many sugar cane growing areas (2 and 6). Whip smut is a serious disease of sugar cane and reaches epiphytonic proportions where susceptible cultivars are grown (7). Smut, therefore, causes significant qualitative and quantitative losses to cane growers worldwide.

There have been no detailed studies carried out to investigate the type of losses caused on sugar cane in the country by *S. scitamineum* in general and especially in terms of dead stools and cane yield. In order to bridge this gap in knowledge and provide sugar cane growers with information on losses and management strategies on whip smut; field and glasshouse studies were conducted at Badeggi, Nigeria, between 1998 and 2000, to assess the losses caused on sugar cane by *S. scitamineum* particularly on the ratoon crop. This paper reports the effects of the whip smut pathogen *S. scitamineum* on the number of dead stools produced with the consequent reduction in yield components and yield as well as total sugar cane loss.

MATERIALS AND METHODS

Fresh smut whips were collected from the field of a Bida local cane in the early hours of each morning for three days. These were dried under shade for one hour, scrubbed with hands covered with sterilized gloves to obtain smut teliospores, and then sieved using 53µm mesh. The sieved teliospores were weighed out in three categories of 10g, 20g and 30g and sealed in cellophane bags and stored in the refrigerator in the laboratory for inoculation process at a later date.

PREPARATION OF PLANTING SETTS

Cane cuttings of variety Co 957 and Bida local cane were made from 7 months old canes. The stalks were detrashed to expose the buds. The stalks were then cut into 3 budded setts and subjected to hot water treatment at 52°C for 30 minutes in separate batches until the whole planting setts were heat-treated. One thousand, nine hundred and twenty (1920) 3- budded setts of each of the two varieties were hot water treated in all. Cane setts were then separated into groups of 120 stalks each representing the four treatments.

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PREPARATION OF SMUT TELIOSPORES SUSPENSION AND INOCULATION

The 10, 20 and 30g smut teliospores earlier weighed out and stored in cellophane bags were each emptied into separate 50 litres of sterile water in three different inoculating containers. These were vigorously stirred to obtain a homogenous suspension of the teliospores' corresponding to 2, 4 and 6 g teliospores litre^{-1} which gave haemocytometer values of 2×10^6 , 4×10^6 and 6×10^6 teliospores/ml concentrations. The heat treated cane cuttings described were then immersed in each of these three-teliospore concentrations for 1 hour and then incubated overnight in wet sterile gunny jute bags and kept under the shade as described by (8). They were then removed and planted in 5m x 5m plots in the field. There was uninoculated control for each of the two varieties.

PLANTING OF THE FIELD TRIAL FOR YIELD LOSS ASSESSMENT

Each treatment (2×10^6, 4×10^6 and 6 x 10^6 teliospores/ml) concentration and the control from the 4 groups was taken to the field in the sterile jute bags and planted in shallow furrows on flat ground. The two varieties formed the main plots; while the different teliospore concentrations (0.2×10^6, 4×10^6 and 6 x 10^6 teliospores/ml) were the sub plots and experiment was planted in a split plot design with four replicates. Each plot consisted of six-5m rows and 1m apart, and the planting setts were laid continuously end-to-end, thus giving no intra-row spacing.

NUMBER OF DEAD STOOLS

The number of dead stools was also recorded during the 1st ratoon crop cycles of two overlapping croppings to determine the ratoonability or otherwise of the two test canes on per plot basis and converted to values per hectare as for the millable and chewable stalks.

The study lasted for two overlapping cropping seasons consisting of two-plant cane (PC) (one each in 1998 and 1999) and two - ratoon canes (RC) (first ratoon of each trial in 1999 and 2000). The 1999 trial was established in a separate field adjacent to that of 1998. Normal agronomic practices were carried out at the required growth stages of the canes till harvest.

DATA COLLECTION ON WHIP SMUT INCIDENCE/SEVERITY, NUMBER OF MILLABLE/CHEWABLE CANES AND CANE YIELD

Data were collected from the four inner rows of each plot (net plot) percent smutted stools and stalks at 3, 6, 9 and 12 months after ratooning (MAR). The number of millable and chewable stalks was also taken at 6, 9 and 12 months first ratoon with the aid of a hand operated tally counter per plot and later converted to per hectare by multiplying the plot value by a factor of 666.67. The weight of single healthy and smutted cane stalks at harvest for the ratoon crops of each of the two plantings was also recorded. All collected data were subjected to analyses of variance (ANOVA), and means were separated using standard error (SE) and Duncan's Multiple Range Test (DMRT).

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Table 1. Effects of variety and inoculum concentration on number of dead stools 1999 and 2000

Treatment	Number of dead stools/ha			
	1999		2000	
	9MAR	12MAR	9MAR	12MAR
Variety (V)				
Co 957	125.0b	125.0b	9833.0a	9833.0a
Bida local	4600.0a	5208.0a	15290.0a	15290.0a
Mean	2362.5	2666.5	12561.5	12561.5
SE+	250.3	83.3	4785.0	4785.0
Sig.	**	**	NS	NS
Inoculum concentration (I)				
(teliospores/ml)				
0.0	2033.0[a]	2333.0[a]	6917.0[a]	6917.0[a]
2 x 10^6	2250.0[a]	2417.0[a]	7750.0[a]	7750.0[a]
4 x 10^6	2250.0[a]	2667.0[a]	15420.0[a]	15420.0[a]
6 x 10^6	2917.0[a]	3250.0[a]	20170.0[a]	20170.0[a]
Mean	2362.5	2666.8	12564.3	12564.3
SE+	731.6	601.6	8036.0	8036.0
Sig.	NS	NS	NS	NS
Interaction				
V x I	NS	NS	NS	NS

Means in a column followed by similar letter(s) are not significantly different at P=0.01 according to Duncan's Multiple Range Test (DMRT)

Sig. = Significance, NS= Not significant, ** = Significant at P=0.01

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Table 2. Effects of variety and inoculum concentration on number of millable and chewable canes, 1998 and 1999 plant and 1999 and 2000 ratoon crops

Treatment	Number of millable and chewable canes									
	1998 Plant Crop			1999 Ratoon Crop			1999 Plant Crop		2000 Ratoon Crop	
	6 MAP	9 MAP	12 MAP	6 MAR	9 MAR	12 MAR	9MAP	12MAP	9MAR	12MAR
Variety (V)										
Co957	68740[a]	105800[a]	105000[a]	99710[a]	91150[a]	106400[a]	116700[a]	119100[a]	90330[a]	85040[a]
Bida local	62420[a]	83830[a]	82580[a]	25750[b]	18850[b]	20080[b]	79750[a]	82080[a]	17130[b]	20580[b]
Mean	65580	94315	93790	62730	55000	63240	148225	100590	53730	52810
SE+	16650	13860	9040	10760	11350	4660	14660	14760	5041	2471
Sig.	NS	NS	NS	**	**	**	NS	NS	**	**
Inoculum concentration (I) (teliospores/ml)										
0.0	78720[a]	1085[a]	107400[a]	64920[a]	59690[a]	72750[a]	103800[a]	106800[a]	65000[a]	62500[a]
2 x 10^6	73330[a]	103800[a]	102900[a]	64830[a]	56420[a]	64920[b]	98750[a]	100800[a]	57250[a]	53330[ab]
4 x 10^6	56920[a]	92170[a]	102000[a]	61420[a]	53170[a]	61500[b]	109800[a]	111800[a]	45420[a]	49420[b]
6 x 10^6	53330[a]	74670[a]	62830[c]	59750[a]	50710[a]	53750[c]	80670[a]	83000[a]	47250[a]	46000[b]
Mean	65575	100335	93783	62730	54998	63230	98255	100600	53730	52812
SE+	9569	12500	11530	13150	11710	4477	16910	17030	9858	3304
Sig.	NS	NS	**	NS	NS	**	NS	NS	NS	**
Interaction										
VxI	NS	NS	NS	NS	NS	NS	*	*	NS	NS

Means in a column followed by similar letter(s) are not significantly different at P=0.01, P=0.05 according to Duncan's Multiple Range Test (DMRT)

Sig. = Significance, NS = Not significant, * =Significant at P=0.05, ** = Significant at P=0.01 Letters a, b and c in Table are for ranking of the means, letters a and b in Table are for ranking the means.

Table 3. Effects of variety and inoculum concentration on smut incidence and cane yield, 1998 plant and 1999 ratoon crops

Treatment	1998 Plant crop					1999 Ratoon crop				
	% Smutted stools					% Smutted stools				
	3 MAP	6 MAP	9 MAP	12 MAP	Yield (t/ha)	3 MAR	6 MAR	9 MAR	12 MAR	Yield (t/ha)
Variety (V)										
Co 957	5.4[b]	9.8[b]	10.7[b]	12.4[b]	115.3[a]	22.3[b]	26.0[b]	27.2[a]	31.0[a]	49.5[a]
Bida local	12.6[a]	17.3[a]	17.1[a]	18.3[a]	82.4[a]	39.1[a]	42.6[a]	30.6[a]	35.5[a]	39.0[b]
Mean	9.0	13.6	13.9	15.4	98.9	30.7	34.3	28.9	33.3	44.3
SE+	1.30	1.30	1.60	1.70	11.5	2.80	2.30	7.7	8.10	0.90
Sig.	**	**	*	*	NS	**	**	NS	NS	**
Inoculum concentration (I) (teliosporesd/ml)										

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0.0	0.0[d]	0.0[d]	0.0[d]	0.0[d]	117.9[a]	2.2[d]	4.4[d]	24.6[b]	28.5[a]	56.2[a]
						22.5[c]	26.3[c]	25.8[ab]	29.1[a]	48.1[b]
2 x 10^6	5.3[c]	9.9[c]	10.6[c]	12.5[c]	106.2[ab]	39.0[b]	44.1[b]	19.6[b]	30.7[a]	42.4[c]
4 x 10^6	10.9[b]	17.5[b]	18.2[b]	19.8[b]	98.6[ab]	58.8[a]	62.5[a]	45.4[a]	44.7[a]	30.3[d]
6 x 10^6	19.7[a]	26.8[a]	26.8[a]	29.1[a]	72.6[b]	30.7	34.3	28.9	33.3	44.3
Mean	9.0	13.4	13.9	15.4	98.8	2.50	2.70	6.80	8.20	2.50
SE±	1.70	2.10	1.40	1.70	12.0	**	**	**	NS	**
Sig.	**	**	**	**	**					
Interaction						**	**	NS	NS	NS
V x I	**	**	**	**	NS					

Means followed by similar letter(s) are not significantly different at P=0.01, P=0.05 according to Duncan's Multiple Range Test (DMRT)

Sig. = Significance, NS = Not significant, * =Significant at P=0.05, ** = Significant at P=0.01, letters a, b, c and d in Table are for ranking of the means.

Table 4. Effects of variety and inoculum concentration on smut incidence and cane yield, 1999 Plant and 2000 Ratoon crops

Treatment	**% Smutted stools**					**% Smutted stools**				
	1999 Plat Crop					**2000 Ratoon Crop**				
	3 MAP	**6 MAP**	**9 MAP**	**12 MAP**	**Yield (t/ha)**	**3 MAR**	**6 MAR**	**9 MAR**	**12 MAR**	**Yield (t/ha)**
Variety (V)										
Co 957	0.3[b]	16.4[b]	53.5[a]	50.2[a]	85.0[a]	24.7[b]	36.5[b]	40.5[b]	42.9[b]	42.8[a]
Bida local	3.9[a]	38.4[a]	62.8[a]	61.2[a]	45.7[b]	39.4[a]	56.1[a]	57.7[a]	60.3[a]	47.1[a]
Mean	3.1	28.9	58.2	55.7	64.4	32.1	46.3	49.1	51.6	45.0
SE±	0.60	7.10	5.10	4.90	2.60	1.60	1.50	1.00	1.30	10.20
Sig.	**	*	NS	NS	**	**	**	**	**	NS
Inoculum concentration (I) (teliospores/ml)										
0.0	1.1[a]	14.3[c]	55.7[a]	50.6[a]	81.9[a]	18.0[c]	29.7[c]	33.3[c]	35.8[c]	33.4[b]
2 x 10^6	1.6[a]	28.3[a]	58.1[a]	52.0[a]	68.5[b]	27.2[bc]	41.6[b]	44.9[b]	46.9[b]	38.1[ab]
4 x 10^6	2.3[a]	27.2[b]	54.1[a]	56.8[a]	59.0[bc]	36.1[ab]	48.0[b]	49.5[b]	53.4[b]	43.5[ab]
6 x 10^6	3.3[a]	39.9[a]	64.7[a]	63.3[a]	52.2c	46.7[a]	66.0[a]	68.6[a]	70.3[a]	64.8[a]
SE±	0.90	4.20	10.30	10.00	3.80	32.00	46.30	49.10	51.60	45.00
Sig.	NS	**	NS	NS	**	**	**	**	**	**
Interaction										
V x I	NS	NS	NS	NS	**	NS	**	NS	NS	NS

Means followed by similar letter(s) are not significantly different at P=0.01, P=0.05 according to Duncan's Multiple Range Test (DMRT)

Sig= Significance, NS = Not significant, * =Significant at P=0.05, ** = Significant at P=0.01, letters a, b and c in Table are for ranking of the means.

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RESULTS AND DISCUSSION

Effects of inoculum concentration and sugar cane variety on number of dead stools, 1999 and 2000 ratoon crops (RC)

Table 1 shows that the two varieties had significant (P=0.01) difference between them on the number of dead stools recorded per hectare in the 1999 ratoon cane. The 2000 ratoon cane showed no significant difference between the two varieties on the number of dead stools. On the contrary, there was no significant increase in the number of dead stools per hectare with increase in inoculum concentration in the 1999 and 2000 ratoon canes. Similarly, interaction of variety × inoculum was not significant.

The significantly greater number of dead stools recorded in Bida local against the lower number in Co 957 could be explained by the fact that Bida local (chewing sugar cane) hardly survives ratooning because of heavy smut infection. This supports the common practice among chewing cane farmers who avoid ratooning to prevent their cane farms from being heavily smutted. Another reason for the observed greater number of dead stools in Bida local than Co 957 could be the nature of the experimental site, which is sandy loam; and chewing cane being accustomed to alluvial soils (9) could hardly survive on this soil type. As ratooning is known to increase smut infection and since a highly susceptible variety like Bida local (5) was inoculated and planted, the ratoon cane could best be heavily smutted; hence the significantly reduced number of chewable canes and greater number of dead stools recorded in Bida local than in Co 957.

The high number of dead stools produced by Bida local further demonstrates the poor ratoonability of the chewing type cane as against the better ratooning ability of Co 957 shown by the fewer dead stools recorded in the 1999 and 2000 ratoon harvests. In major cane growing countries, two or more ratoon cycles are normal practice (10). Ratooning helps in reducing environmental pollution and protects soil along with its fauna (11). Proper development of ratoon is dependent on sprouting of underground buds that remain after harvesting of the plant crop (12).

Mortality of tillers is a problem in sugar cane related to pathology, entomology, agronomy and physiology (13). Thus, the high number of dead stools recorded by Bida local and Co 957 varieties corroborates the report by (13), that diseases cause tiller mortality in sugar cane resulting in dead stools as witnessed in the present study where smut infected canes recorded higher number of dead stools which resulted in reduced number of millable and chewable canes as well as cane yield per hectare.

This underscores the wisdom of chewing cane growers who at present avoid maintaining the ratoon of their canes to escape this loss but incur additional wages and cost on land preparation and seed cane. The implication is that chewing sugar cane should be effectively managed against infection by *S. scitamineum* as its effect, particularly on the ratoon crop destroys and kills the cane, producing dead stools resulting in total loss to the grower.

Effects of sugar cane variety and inoculum concentration on number of millable and chewable canes, 1998 and 1999 plant crops and 1999 and 2000 ratoon crops.

Results presented in Table 2 show that the two varieties had no significant millable and chewable number difference in the 1998 and

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1999 plant canes. In the 1999 ratoon cane Bida local consistently had less number of chewable canes than the number of millable canes produced by Co 957.

Table 2 also shows that there was no significant decrease in the number of millable and chewable canes with increase in inoculum concentration in the 1999 ratoon cane at 9 MAR. Significant (P=0.01) number difference was recorded at 12 MAR in the 1999 ratoon cane on millable and chewable canes with increase in inoculum concentration, except that the number of canes from setts inoculated with 6×10^6 teliospores/ml inoculum was significantly less than that from setts inoculated with 4×10^6 and 2×10^6 teliospores/ml. Interactions of variety ×inoculum concentration were not significant on number of chewable and millable canes in the 1999 ratoon canes.

Similarly, in the second year evaluation, the two varieties had no number difference of millable and chewable canes between them. Effects of variety and inoculum concentration were significant on number of millable and chewable canes only in 2000-ratoon cane at 12 MAR. Similarly, interactions of variety and inoculum concentration were not significant with 2000 ratoon cane (Table 2).

In general, the two test varieties showed significant difference in number of healthy and millable and chewable canes produced by them. Similarly, the number of millable and chewable canes was reduced with increase in inoculum concentration in the present study. The observed significantly reduced number in healthy and millable and chewable stalks with increasing inoculum concentration corroborates reports by (14) and (15); who observed that the most significant effect of whip smut on cane was the reduction in the number of healthy stalks of affected canes. It also corroborates other reports by (16) and (17), who observed reduction in crushable or millable stalks by *S. scitamineum* in their separate studies and of course the significant reduction in chewable canes as well, recorded in the present study due to the dead stools.

Effects of inoculum concentration and sugar cane variety on whip smut incidence and yield, 1998 plant and 1999 ratoon crops

Table 3 shows that in 1998, there was highly significant (P = 0.01) decrease in yield of the two test canes. Also at 3, 6, 9 and 12 MAP, there was significantly higher incidence of smutted stools of Bida local than Co 957. The same table also shows that in 1998, at 3, 6, 9 and 12 MAP, there was highly significant (P = 0.01) increase in incidence of whip smut on sugar cane stools with increase in inoculum concentration. There was highly significant (P = 0.01) interaction of variety and inoculum concentration on incidence of smutted stools. There was no significant interaction of variety and inoculum concentration on cane yield.

Table 3 also shows that in 1999 at 3 and 6 MAR, there was highly significant (P = 0.01) incidence of smutted stools of Bida local than Co 957, but no significant difference on disease incidence was observed at 9 and 12 MAR between the two varieties. At 3, 6, and 9 MAR, there were highly significant (P = 0.01) increase on disease of whip smut on sugar cane stools with increase in inoculum concentration, except that at 12 MAR the difference in incidence of whip smut on stools was not significant.

The yield of Bida local was significantly lower than that of Co 957 (Table 3). Similarly, in 1999, there was highly significant (P = 0.01) decrease

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in yield as inoculum concentration increased. The 6 x 10^6 teliospores/ml inoculum concentration produced significantly the least cane yield as against the significantly highest yield produced by the check. Interaction of variety and inoculum concentration was, however, not significant. Table 3 also shows that Bida local treated with 6 x 10^6 teliospores/ml inoculum concentration had significantly (P = 0.01) higher incidence of smutted stools than the other treatments at 3 MAR, but not Co 957 treated with the same inoculum concentration. At 6 MAR, a similar result was obtained for both varieties.

Sporisorium. scitamineum being seed transmitted builds up in the ratoon crop as the result of the inoculum source established from first infection (18). Thus, in the present study, the least yield recorded in the ratoon crops of Bida local and Co 957 which were inoculated with the 6 x 10^6 teliospores/ml inoculum concentration must have been the effect of the subsequent build up of the pathogen in the test canes and which corroborates the reports by (18) and (19).

Effects of inoculum concentration and sugar cane variety on whip smut incidence and yield, 1999 plant and 2000 ratoon crops

Table 4 shows that the yield of the two varieties was significantly different from each other, with Bida local producing lower yield than Co 957 in the 1999PC. Similarly, the 1999PC gave highly significant (P = 0.01) decreased yield as inoculum concentration increased. The differences between the yield of cane following application of inoculum concentration of 6 x 10^6 and 4×10^6 teliospores/ml, and 2×10^6 teliospores/ml were not significant but significant with the check. Interaction of variety and inoculum concentration on the yield of cane inoculated with whip smut was similarly significant.

The result of the 2000RC presented in Table 4 shows that at 3, 6, 9 and 12 MAR, there was significantly higher incidence of smutted stools of Bida local than Co 957. Also at 3, 6, 9 and 12 MAR, the 2000RC had significant (P = 0.01) increase in disease of sugar cane whip smut on stools with increase in inoculum concentration. There was similarly, significant (P = 0.01) interaction of variety and inoculum concentration on incidence of smutted stools at 6 MAR. Table 4 similarly shows that in 2000RC, there was no significant difference between the yield of Bida local and Co 957. In contrast, the ratoon yield was significantly (P = 0.01) decreased with increase in inoculum concentration while interaction of variety and inoculum concentration was not significant.

The markedly reduced cane weights resulting from the highest inoculum concentration in this study supports the findings by several workers that smut infection reduces cane yield (15; 20; 21; and 22). Each of the inoculum concentrations recorded its own markedly reduced weight effect on the test canes corresponding to the strength of the inoculum present at the time of infection at inoculation. Differences in smut effect have been known to occur as a result of initial inoculum (23). Therefore, the observed significant differences on weights of infected canes in the present investigation are in line with the findings by other workers in other sugar cane producing areas such as Brazil where smut effects have been documented (18, 19 and 23).

Whip smut caused significant loss of Co 957 and Bida local in all the two plant cycles between 1998 and 2000 in terms of reduced cane weight and this study has thus

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established detailed documented evidence on the yield components and cane yield losses incited on sugar cane by *S. scitamineum* in Nigeria. Sustainable management strategies are the next line of research to reduce the effect of whip smut on sugar cane in the country.

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REFERENCES

[1] Obakin, F.O., 1978. Sugar cane improvement at National Cereals Research Institute. Pp.12-16 In: *Proceeding of an International Symposium on Sugar cane in Nigeria* NCRI, Moor Plantation, Ibadan, Nigeria, August 28 to September 1, 1978.

[2] Sivanesan, A. and J.M. Waller, 1986. Sugar cane diseases. CMI Phytopath. Paper No. 29. CAB Int. Tarnham House, Slough SL23BN, UK. 88pp.

[3] Wada, A.C., 1997. Some Important Diseases and Pests of sugar cane in Nigeria and their control. *Outlook on Agriculture* 26(2): 101-105.

[4] Wada, A.C., O.A. Fademi and S.M. Misari, 1998. Assessment of Sugar cane Diseases and Pests in ten Northern States and the Federal Capital Territory of Nigeria. *Bangladesh J. Sugar cane* 18 – 20: 37 – 45.

[5] Wada, A.C.; M.E. Abo; S. Agboire; F.O Obakin and B.A. Okusanya, 1999. Incidence, Severity and Distribution of Sugar cane Diseases in Nigeria. I. Southern Guinea Savanna Zone. *Discov.innov.* 11(1/2): 33-39.

[6] Bebee, C.N., 1988. Smut Pp 230-234 In: Chattes N. Bebee (ed). *The Protection of sugar cane and sugar Beets.* Pub. Longman Inc. New York.

[7] Villalon, B., 1982. Sugar cane smut in Lower Rio Valley of South Texas. *Plant Disease* 66:605-606.

[8] Nasr, I.A., 1977. Standardization of inoculation techniques for sugar cane smut disease. *Sugar cane Pathol. Newsletter* 18:2-5.

[9] Akobundu, I.O., 1987. Sugar cane Pp 414-416 In: Akobundu, I.O. (ed). *Weed Science* Chrenag. John Wiley and Sons.

[10] Singh, I. S., R. Singh., M. P. Yadav and R. Singh 2003. Ratooning behaviour of New promising varieties of sugar cane under Bhat conditions. *Indian sugar.* 53 5 333-336.

[11] Mohammad, S., M. Saed., B. Shahid and K. R. Mohammad. 2011. Studies on the rationing potential of different sugar cane varieties harvested on different dates. *Balancing Sugar and Energy Production in Developing. Countries: Sustainable Technologies and Marketing Strategies*, New Delhi, India, Pp220-223.

[12] Hunsigi, G and K. R Krishna. 1988. Science of field Crops. Oxford & IBH Publishing Co. (Pvt) Ltd, New Delhi, Pp 328-352.,

[13] Yadav, R.L 1991. Sugar cane Production Technology, Constraints and Potentialities. Oxford & IBH Publishing Co. (pvt) Ltd Bombay p204.

[14] Mathur, R.B.L. Snu t(Ustilago scitaminea Syd.) In: R.B.L. Mathur (Ed.) Handbook of cane sugar technology Oxford & IBI + Pub. Co. PVT.Ltd, New Delhi 13– 14 (1975)

[15] Hoy, J.W.; C.A. Hollier; D.B. Fontenot and L.B. Grelen, 1986. Incidence of sugar cane smut in Louisiana and its effects on yield. *Plant Disease* 70(59-60.

[16] Valladares, A.F and H.R. Gonazales, 1986. The quality and yield lowering effect of the sugar cane smut *Ustilago scitaminea. Bulletin INICA* 1986. 2:60-68. In RPP 69(2): 162-263.

[17] Villalon, B and W.C. Warfield, 1988.

ISSN: 0975 - 4539
IJBSAT (2018), 9(5):32-42

DOI: http://doi.org/10.5281/zenodo.1486289

Evaluation of sugar cane hybrids for resistance to sm 1981 - 85. Miscellaneous publication. Texas Agric. Exp. Sta. (1988) No. 1660, 88pp. In RPP 68(7): 344.

[18] Comstock, J. C. 2014. Seed Piece Transmissible Diseases in Sugarcane and their Management. Proceeding of the International Conference IS-2014 on Green Technologies for Growth of Sugar & Integrated Industries in Developing Countries Held at Nannig PR. China 25 -28 November 2014.

[19] Wada, A.C. and A. B. Anaso. 2016. Yield Components and cane yield losses of two sugar cane varieties affected by whip smut (*Sporosorium scitamineum* Syd.)I Nigerian. Journal of Crop Science Research 1 (1):1-15.

[20] Keswani, 1982. Effect of sugar-cane smut on yield and yield components of sugar cane varieties in Tanzania. *Trop. Agric.* (Trinidad) 59(3): 243-247.

[21] Kumar, S.; D. Kumar and R.N. Sinha, 1989. Change in yield attributes, juice quality a mineral nutrients in cane juice due to smut infection. *Indian Sugar* 39(4): 233-237.

[22] Padmanaban, R.; K.C. Alexander and N. Shanmugan, 1988. Effect of smut on growth and yield parameters of sugar cane. *Indian Phytopathology* 41(3): 367-369. In: RPP 70(9): 754.

[23] Bergamin, A.F. and L. Amorim, 1994. Effect of the initial inoculum of sugar cane smut development. "*Current Trends in sugar cane Pathology"* Eds G.P. Rao *et al* Pp 49-58. In: *Sugar cane* No.5: